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Mazdoor Kisan Shakti Sangathan

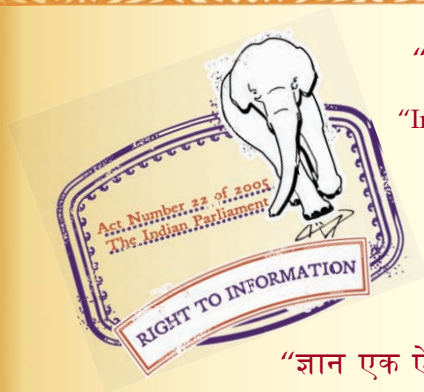
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“Step Out From the Old to the New”

IS 10724 (1990): ACCEPTANCE STANDARDS FOR MAGNETIC PARTICLE
INSPECTION OF STEELCASTINGS- [MTD 14: Foundry]



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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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Indian Standard

ACCEPTANCE STANDARDS FOR MAGNETIC
PARTICLE INSPECTION OF STEEL
CASTINGS — SPECIFICATION

(First Revision)

भारतीय मानक

इस्पात ढलाइयों के चुम्बकीय कण के निरीक्षणार्थ स्वीकार्यता —
विशिष्ट

(पहला पुनरीक्षण)

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 26 April 1990, after the draft finalized by the Steel Castings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Magnetic particle inspection is a non-destructive test method for detecting discontinuities on or near the surface in suitably magnetised materials, which employs finely divided magnetic particles that tend to congregate in regions of leakage fields. This method has found widespread application and is an inspection tool of major importance for detection of cracks, seams, laps, laminations, inclusions, etc, found in magnetic ferrous materials.

To aid in the process of evaluation and determining the limits of acceptance of surface discontinuities detected by magnetic particle inspection, this standard was published in 1983. In this revision among other things, following main modifications have been made:

- a) A definition of magnetic material has been incorporated;
- b) A stipulation concerning the required lighting for visual inspection is made; and
- c) A provision for demagnetisation has been incorporated.

To use this standard 'Standard reference photographs for magnetic particle indications' published under ASTM-E-125-63 (1980), are required (*see* Table 3). These are available from American Society of Testing and Materials 1916, Race Street, Philadelphia 19103, USA.

Indian Standard

ACCEPTANCE STANDARDS FOR MAGNETIC PARTICLE INSPECTION OF STEEL CASTINGS — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard deals with the acceptance standard for discontinuities at or near the surface, detected by magnetic particle inspection for steel castings. The procedure adopted for this examination is as specified in IS 3703 : 1980 'Code of practice for magnetic particle flaw detection (first revision)'.

1.2 A steel shall be considered to be magnetic if the magnetic induction is greater than 1 Tesla for a magnetic field equal to 2.4 kA/m. This standard does not apply to the testing of non-magnetic or feebly magnetic material such as austenitic steel.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard.

IS No.	Title
3415 : 1980	Glossary of terms used in magnetic particle flaw detection (first revision)
3703 : 1980	Code of practice for magnetic particle flaw detection (first revision)
5334 : 1981	Code of practice for magnetic particle flaw detection of welds (first revision)
6410 : 1971	Magnetic flaw detection inks and powders
8780 : 1978	Code of practice for non-destructive testing of steel castings

3 TERMINOLOGY

3.1 For the purpose of this standard, definitions given in IS 3415 : 1980 shall apply.

4 EQUIPMENT

4.1 Magnetizing Current

Alternating, direct or rectified magnetizing current shall be used. Unless specified in the enquiry and order, the type of magnetizing current to be used and whether the wet or the dry method is to be followed shall be at the discretion of the manufacturer. An average magnetizing current

according to the section thickness and prod spacing as shown in Table 1 shall be applied. If a source of magnetizing current with an open circuit voltage of over 25 V is used, lead, steel or aluminium, rather than copper, tipped prods are recommended to avoid copper penetration.

4.2 Prods shall be kept free of iron pick-up by frequent filing. Areas subjected to arcing shall be ground to clean metal wherever necessary.

5 CALIBRATION OF EQUIPMENT

5.1 Frequency of Calibration

Each piece of magnetizing equipment shall be calibrated at least once a year or after each time it has been subjected to major electrical repair, periodic overhaul or damage.

5.2 Equipment with Ammeters

5.2.1 Procedure

The units meter readings shall be compared to those of a control test meter with shunt or current transformer arrangement, connected so as to monitor the output current. The accuracy of the entire control test meter arrangement shall be verified annually. Comparative readings shall be taken at a minimum of three output levels encompassing the usable range.

**Table 1 Average Magnetizing Current for
Magnetic Particle Inspection for Steel Castings**

(Clause 4.1)

Prod Spacing* mm	Magnetizing Current to be Applied	
	Section Thick- ness Below 20 mm	Section Thick- ness 20 mm and Over
A	A	A
50 to 100	200 to 300	300 to 400
100 to 150	300 to 400	400 to 600
150 to 200	400 to 600	600 to 800

*Prod spacing less than 75 mm usually is not advisable due to banding of the particles around. By agreement between the manufacturer and the purchaser a higher prod spacing than is shown above together with a correspondingly higher current may be employed.

5.2.2 Tolerance

The unit's meter reading shall not deviate by more than ± 10 percent of full scale, relative to the actual current values as shown by the test meter.

NOTE — When half-wave current is involved, the direct current test meter current readings shall be doubled for the calibration.

5.3 Materials for Magnetic Particle Inspection

The defect indications may be obtained by means of the following media, any one of which may be used at the discretion of the manufacturer unless otherwise specified in the enquiry and order.

- Dry magnetic powder stable up to 350°C (for normal magnetic particle inspection and at elevated temperatures).
- Dry magnetic powder with coloured pigment.
- Magnetic powder suspended in an aqueous or hydrocarbon liquid.
- Fluorescent magnetic powder suspended in an aqueous or hydrocarbon liquid.

NOTE — The last three materials may be used only at ambient temperature.

5.3.1 For aqueous suspensions, the liquid shall contain an anti-rust additive and a surface active additive.

5.3.2 The powder shall be of a size, shape and colour such that it will ensure a suitable sensitivity and contrast when used in the intended manner.

5.3.3 Verification of the quality of magnetic particle material is very important. It is to be ensured before test that all the powder or particles are attracted to the magnet.

5.3.4 In order to verify the purity of the particles contained in the liquid, a sample of the material may be allowed to settle after shaking, deposit collected, cleaned, dried, weighed and ensured that all of it gets attracted to the magnet.

5.3.5 Bath concentration for wet magnetic particle inspection may be checked before use of red or black indicating material, the recommended concentration for a 100 ml sample is 1.2 to 2.4 ml. For fluorescent paste, the recommended concentration is 0.7 to 1.0 ml.

6 TYPES OF INDICATIONS

6.1 Circular Indications

Circular indications are those more or less elliptical with major axis not more than three times the minor axis.

6.2 Linear Indications

Linear indications are those having the largest dimension equal to at least 3 times the smallest.

6.3 In-Line Indications

In-line-indications are those found in a group of three or more indications.

6.4 The type of casting/weld defects and the corresponding likely indications are listed in Table 2.

Table 2 Defects and the Corresponding Indicators
(Clause 6.4)

Type	Type of Defect	Likely Indication
(1)	(2)	(3)
I	Linear discontinuities	Ragged lines of variable width may appear as a single jagged line or exist in groups. They may or may not have a definite line continuity. They usually originate at the casting surface and generally becomes smaller as they go deeper.
II	Shrinkage	Appears as a jagged area or irregular patches. Shrinkage is a sub-surface discontinuity that may be brought to the surface by machining or other methods of metal removal.
III	Inclusions	Isolated, irregular or elongated indications of magnetic particles occurring singly in a linear distribution or scattered at random in feathery streaks. The indications are the result of the presence of sand, slag or oxides in the surface metal.
IV	Internal chills and unfused chaplets	A uniform line or band outlining the object and indicating lack of fusion between the metal object and the casting.
V	Porosity	Appears as rounded and elongated clusters of magnetic particles, of various sizes scattered at random.
VI	Welds	Incomplete fusion and penetration appears as a straight continuous or intermittent linear indication. Porosity inclusions and linear discontinuities in welds appear as described above.

6.5 Detection of the discontinuities is connected with the direction of the magnetic flux in the casting. Therefore, it is essential to carry out a check in two directions which are essentially perpendicular, to make sure that the discontinuity lies across the flux in at least one direction.

7 EVALUATION OF INDICATIONS

7.0 Prior to evaluation, it is necessary to confirm that the discontinuities as revealed are true defects and not a result of localized surface irregularities due to machining marks or other surface conditions as they may produce false indications.

7.1 In case any indication is suspected to be non-relevant, it is to be considered relevant until it is proved otherwise.

7.2 The surface of the casting shall be smooth enough to facilitate effective examination and to prevent broad areas of particles accumulation which could mask significant indications of discontinuities. Ordinarily the surface finish shall be equal to or better than 25 μm .

7.3 All indications of size under 1.5 mm shall be ignored as not significant.

7.4 All significant indications shall be evaluated as indicated in Table 3.

7.5 It is to be considered that the magnetic particle inspection, like all methods of non-destructive inspection forms a part of an overall assessment of the quality of a casting and may not ordinarily be treated as the sole criterion of acceptance.

7.6 The area to be examined shall be suitably illuminated to permit satisfactory evaluation of the indications revealed on the test surface. Examination is carried out visually in suitable lighting conditions. The minimum value of luminance is 500 flux in day light. In case artificial light is used, a minimum luminosity of 8 W/m^2 is to be provided.

8 ACCEPTANCE LIMITS

8.0 Castings are classified into five quality levels namely 1, 2, 3, 4 and 5 as given in Table 3, according to the maximum permissible size and quantity of defects recorded. The special quality level 1A is applicable only to the specified regions of certain types of castings, as stated in 8.2.

8.1 The maximum permissible discontinuities relate to the quality levels as indicated in the enquiry and order (or drawing).

8.2 Unless otherwise agreed upon in advance, quality level 1A is applicable only to castings used for creep resistant applications (that is exposure to high temperatures and fluid pressures), at the fabrication weld zone that is, the region representing weld preparation plus the adjoining 40 mm length of the casting as shown in Fig. 1.

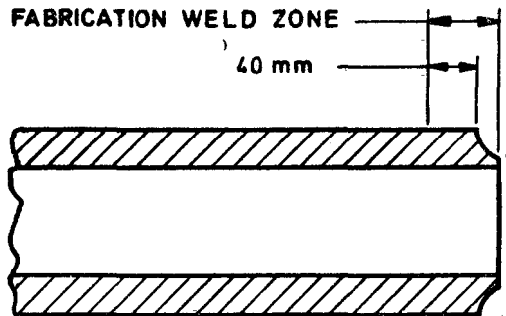


FIG. 1 FABRICATION WELD ZONE

9 DEMAGNETIZATION

9.1 When so specified in the enquiry and order the castings may be demagnetized after carrying out the inspection. The demagnetization may be carried out as specified in IS 3703 : 1980.

**Table 3 Maximum Permissible Size and Quantity of Discontinuities or Defects as Detected by
Magnetic Particle Inspection
(Clauses 7.4 and 8)**

Type of Discontinuities		Maximum Permissible Discontinuity/Indication Sizes							
		Quality Level 1A (Applicable to Fabrication Weld Zone (see Fig. 1 and 8.2)	Quality Level 1		Quality Level 2		Quality Level 3	Quality Level 4	Quality Level 5
			Wall Thick- ness 50 mm and Below	Wall Thickness Above 50 mm	Wall Thickness 50 mm and Below	Wall Thickness Above 50 mm	*	*	*
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LINEAR (see 6.2)	On surface exposed after machining or on inner 'as cast' surface directly subjected to fluid pressure	None	3 mm	5 mm	3 mm	5 mm	I - 3 a to I - 3 c	I - 4 a to I - 4 c	I - 5 a to I - 5 c
	Number of indication permissible in an area of 10 cm × 10 cm wherein the shortest distance between two adjoining discontinuities is not less than 3 times the extent of larger discontinuity	None	10	10	10	10	10	10	10
	Number of indications permissible in an area of 5 cm × 5 cm having a distance of minimum 2 mm between adjoining indications	None	10	10	10	10	10	12	15
	On other 'as cast' surfaces	None	I - 1 a to I - 1 c	I - 1 a to I - 1 c	I - 2 a to I - 2 c	I - 2 a to I - 2 c	—	—	—
	Porosity (Applicable to all surfaces)	Maximum permissible size of an individual indications (mm)	None	3 mm	5 mm	3 mm	5 mm	5 mm	6 mm
	No. of indications permissible in an area of 5 cm × 5 cm	None	10	10	10	10	10	10	10
Surface shrink holes	On surface exposed after machining or inner 'as cast' surface directly subjected to fluid pressure	None	II - 1		II - 1		II - 2	II - 3	II - 3
	On other 'as cast' surface	None	II - 2		II - 3		II - 3	II - 4	II - 5
Inclusions (non-metallic) (applicable to all surfaces)		None	III - 2		III - 3		III - 3	III - 4	III - 5
Chills and unfused chaplets (applicable to all surfaces)		None	IV - 1		IV - 2		IV - 3	IV - 4	IV - 5

*Applicable to all thicknesses and to all surfaces.

NOTES

1 The evaluation and designation of discontinuities or defects shall be as specified in ASTM—E—125—63 (1980)—'Standard reference photographs for magnetic particle indications on ferrous castings'. These reference photographs are available in four charts arranged for each type of discontinuity. Charts are available from American Society of Testing and Materials, 1916, Race Street, Philadelphia 19103 USA.

2 The numbers I - 1 a, I - 2 a, II - 1, etc, shown above refer to the number of corresponding standard reference photographs in the above mentioned ASTM.

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